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Creative Multi-Disciplinary Learning Incorporating Da Vinci-Style Thinking for Gifted Students

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CREATIVE MULTI-DISCIPLINARY LEARNING INCORPORATING DA VINCI-
STYLE THINKING FOR GIFTED STUDENTS

A Project
Presented to
The Graduate Faculty
Central Washington University

In Partial Fulfillment
Of the Requirements for the Degree
Master of Education
Master Teacher

by
Amelia Melissa Ferrell

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ABSTRACT

CREATIVE MULTI-DISCIPLINARY LEARNING INCORPORATING

DA VINCI-STYLE THINKING FOR GIFTED STUDENTS

by

Amelia Melissa Ferrell

January 2013

The need for creative inspiration for gifted students was examined with the understanding that gifted students typically have a mastery of the basics required by state standards, or can obtain it quickly, and often need a challenge to allow them to rise to their full potential (Tanggaard, 2011). A lack of inspiration can lead gifted students to stagnate, rather than excel, and is a common problem in the typical school system (Bilek, Erdogan, Fančovičova, Kubiátko, Lamanauskas, Prokop, Šašić, Šorgo, Tomažič, 2012). Using the multi-disciplinary learning style modeled by Leonardo da Vinci, students learn a foundational knowledge in a wide variety of subjects and are then able to use this understanding to launch into their own creative projects that show an extension of learning, based on student interest. Rather than focus on state testing results, the ability to think creatively, while demonstrating knowledge beyond basic learning, is prized as the desired outcome. Allowing students to follow passions and inspirations result in deeper thinking and a love of learning (Mildrum, 2000).

This project reviews the merits of interdisciplinary study with a focus on creative

thinking, using the foundational knowledge of the life studies of Leonardo da Vinci to teach students concepts in math, science, art, and social studies. From these learnings, students will develop projects of interest that show their basic learning extended into creative student-developed projects.

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CHAPTER I

BACKGROUND OF THE PROJECT

Introduction

The need for creative inspiration for gifted students was examined with the understanding that gifted students typically have a mastery of the basics required by state standards, or can obtain it quickly, and often need a challenge to allow them to rise to their full potential (Tanggaard, 2011). A lack of inspiration can lead gifted students to stagnate, rather than excel, and is a common problem in the typical school system (Bilek, Erdogan, Fančovičova, Kubiato, Lamanauskas, Prokop, Šašić, Šorgo, Tomažič, 2012). Using the multi-disciplinary learning style modeled by Leonardo da Vinci, students learn a foundational knowledge in a wide variety of subjects and are then able to use this understanding to launch into their own creative projects that show an extension of learning, based on student interest. Rather than focus on state testing results, the ability to think creatively, while demonstrating knowledge beyond basic learning, is prized as the desired outcome. Allowing students to follow passions and inspirations result in deeper thinking and a love of learning (Mildrum, 2000).

This project will review the merits of interdisciplinary study with a focus on creative thinking, using the foundational knowledge of the life studies of Leonardo da Vinci to teach students concepts in math, science, art, and social studies. From this learning, students will develop projects of interest that show their basic learning extended into creative student-developed projects.

Statement of the Problem

When looking at inspiring gifted students, it is important to go beyond basic learning of state standards into application of creative thinking from this basic knowledge in order to have students working at their own personal capacity. If students are simply offered the opportunity to do “busy work” to fill their time, the school system is not serving students to work at their full potential (Mildrum, 2000). Additionally, the demand for performance on state testing has homogenized the learning experience, encouraging teachers to favor easily measureable results over the more subjectively evaluated creative projects (Bilek, Erdogan, Fančovičova, Kubiato, Lamanauskas, Prokop, Šašić, Šorgo, Tomažič, 2012). Creative projects that follow spontaneity and inspiration are often redirected for the ease of teaching a large group of students in a way that can show growth and meet teaching expectations with a set curriculum that all teachers within a district are teaching (Bilek, et al., 2012).

Incorporating integrated studies that unite as much diverse basic curriculum as possible enables teachers to meet the basic learning requirements, while exposing students to various topics which may be of interest to them (Hinde, 2005). From an integrated curriculum students may be inspired to explore a topic in a more in-depth format, if allowed to do so. When topics are selected by students, and they are allowed to explore them creatively, through divergent thinking, discussion and self-directed projects, interest increases and basic knowledge is then used to produce something innovative (Tanggaard, 2011). It is this type of innovative thinking that is prized in a world of leaders as adults, but without encouragement in schools students do not have opportunity to practice and develop creative thinking (Bilek, et al., 2012). Many gifted programs,

including the local district's program, focus on a once per week pull out system, rather than a full school experience, so gifted students have very little opportunity to go beyond basic classroom learning that is primarily focused on achieving a level 3 proficiency (meeting standard) on district, such as the classroom based assessments designed by the district for use in the same grade level across the district, and state assessments such as the Measurement of Student Progress (MSP). This is problematic because it does not push gifted students to go beyond a basic understanding of academic subject matter.

Purpose of the Project

The purpose of the project was to create a unit for 4th/5th grade gifted students, inspired by the creative learning style of Leonardo da Vinci, that extends basic knowledge required by district and state assessments into a learning experience that values individual creative thought and inspiration. This unit allows students to diverge from basic knowledge and follow student-inspired ideas into projects of their choosing, within parameters that meet teacher-identified goals. These student-centered ideas should serve to foster creative thinking and move gifted students beyond busy work to learning that invigorates (Mildrum, 2000).

The projects are designed to give students a basic experience to build knowledge in a variety of subjects, such as science, mathematics and art. From this base knowledge students are encouraged to think creatively about what they would like to do to extend their understanding through student-designed projects.

Significance of the Project

Leonardo da Vinci was known to follow his passions and was endlessly learning through his own motivation to do so (Rhoades, 1993). Having students learn the art of creative thinking, which includes comfort in risk-taking, improvisation, challenging paradigms and reflecting on learning and outcome, from a teacher modeling the same type of teaching, produces motivated learners that are able to apply learning to new contexts (Tanggaard, 2011).

The project includes exposure to math, science, art and literacy, addressing state standards, but with the outcome assessed valuing creative thought and student innovation as the primary goal. Since da Vinci experimented in each of those subjects, developing an integrated unit from his life studies, as they relate to 4th/5th grade curriculum, will model basic learning while encouraging innovation (van Loo, 2010). Students will be able to monitor their learning through checklists of basic understandings that will ensure district and state requirements are addressed while expressing that learning through their own inspired ideas. Students will not be expected to show all of their learning within their projects (as this becomes a type of busy work that can thwart creativity) but assessment will identify whether understanding of basic concepts is clear from the completion of the project.

Limitations of the Project

This is a unit designed for 4th/5th grade gifted students. It was designed to be used in alignment with the local school district and Washington State standards by a self-contained gifted classroom, though it could be modified to be used in a regular classroom as well.

Definition of Terms

The following are definitions, which will assist the reader in understanding the educational terms used in the project:

Divergent Thinking: “Thinking outwards instead of inward. It is the ability to develop original and unique ideas and then come up with a problem solution or achieve an objective” (Problem-solving-techniques.com).

Gifted: “Students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities” (www.nagc.org).

Integrated Curriculum: “Systematic organization of curriculum content and parts into a meaningful pattern” (Education.com).

Integrated, Interdisciplinary Instruction: “A teaching strategy that combines curriculum and academic standards from more than one content area. This instructional approach can be used on applied projects, thematic instruction, service learning projects, social-issue investigations, science-technology-society investigations, and simulations.” (Education.com).

Literacy: “Literacy is the ability to use printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential” (National Assessment of Adult Literacy).

Paradigm: “A pattern or model of how something is structured (the parts and their interrelationships) and how the parts function (behavior within a specific context or time dimension)” (Educational Psychology Interactive).

State Standards: Criteria established by an educational institution to determine levels of student achievement (Education.com).

Standardized Testing: “Tests that are administered and scored under uniform (standardized) conditions. Because most machine-scored, multiple-choice tests are standardized, term is sometimes used to refer to such tests, but other tests may also be standardized. Also, tests that are usually commercially prepared for nationwide use to provide accurate and meaningful information on student's level of performance relative to others at their age or grade levels” (Education.com).

Project Overview

Chapter one includes a background of the project with a statement of the problem of gifted students not being adequately inspired and challenged, plus the purpose, significance and limitations of the project. It also includes a definition of terms. Chapter two offers an overview of the project with historical context and a literature review supporting the need for gifted education to extend beyond basic learning to increase creativity and inspiration. Chapter three explains the background of the project including the procedure, development and implementation of the project. Chapter four summarizes the project and chapter five provides a summary of the project with recommendations and implications. Finally, the appendix contains the lessons to be taught to students by teachers of gifted students in 4th/5th grades.

CHAPTER II

HISTORY OF TEACHING CREATIVITY AND INTEGRATED CURRICULUM IN THE CLASSROOM IN CONNECTION TO GIFTED EDUCATION

Early education in America was focused on learning of the basics of literacy, arithmetic and morality and was designed to fit into an agricultural society. Recitation, performing drills and responding through quiz format was the preferred model of teaching (Roundtable, 2001). Early innovators though, such as Horace Mann in the 1800's, while continuing the focus on a basic skill set, appreciated the value of creating original thought for the good of the democratic society (Morgan, 1937). Because a skilled citizenry was important to the building of the economy and world leadership, though the topic was considered to be dubbed problem-solving rather than the term creativity as used in this work, a value was placed on being able to think innovatively.

In Morgan's summation of Horace Mann's philosophy (1937), he quotes Mann:

If we find new constellations in the heavens, or discover new features in stars already known, we demand a telescope of greater space-penetrating power. No longings, no night-watchings, no aspirations, will ever enable us to see one inch beyond the capacity of our glass. Give me a 'larger eye,' says the astronomer, and I will reveal to you another rank of worlds marshaled behind those whose shining hosts you now behold. Rear stronger minds, says the lover of light and truth, and they will lift up the race to sublime heights of dignity and power. In this way, we shall obtain thought-producing instead of thought-repeating men. (p. 600)

While basic knowledge was of value, even early educational innovators saw the need for thinking extending beyond a simple understanding of basic concepts, as illustrated by the words of Mann. Though the method of testing through what is known as “drill and recitation” continued throughout the 1800’s, the arrival of the philosophical differences brought about by John Dewey started to change teachers’ assessment of student learning as experience became favored over test-taking (Roundtable, 2001). The students’ abilities and development should be included, as well as the real world outside of the classroom environment. Child-centered education became favored and though the ideas are still said to be valued today, the time spent test-taking and teaching test-taking skills has increased dramatically throughout the years as states strive for a unified educational system where all students learn the same content (Roundtable, 2001).

Taking a decidedly less popular approach, where classism was validated and the value of a gifted student to society was offered as potentially having a more profound impact than a handful of average or below par students, Ellwood Clubberley called attention to the differences between students in the end of the late 1800’s and early 1900’s (Roundtable, 2001). His system of administration from the top down approach set the standard for decision-making for education and while he is controversial, many of his strategies for management of the educational system are still in place. Whether that has furthered education for talented students or homogenized them with a systematic approach to education is debatable (Roundtable, 2001).

The effort to classify intelligence with testing began when Alfred Binet and Theophile Simon created the first intelligence test in 1905 in France. These tests were introduced to the United States in 1905 by Henry Goddard and given to children that

were deemed mentally deficient (Franklin, 2007). These tests began to be used widely in public schools in the 1920's. They were distributed to African-American, Native American and Mexican children and were used to deem them mentally inadequate compared to their white counterparts. The topic of cultural insensitivity remains ongoing with many methods of intelligence testing used to evaluate the gifted (Franklin, 2007).

With the use of intelligence testing measures and a changing political environment that included advancements by the Soviet Union with the launching of Sputnik in the 1950's, the United States began to recognize a greater need to identify and better serve gifted students, for the betterment of the nation (National Association for Gifted Children, 2008). With the desire for global competitiveness stemmed from the success of the Soviets, the first large-scale federal funding of gifted education in America, The National Defense Education Act, passed in 1958.

Over the next 20 years, gifted education became recognized as valuable, although it was not tied to special education, which was seen as an oversight by proponents of gifted education, especially because the funding for special education was sizeable (National Association for Gifted Children, 2008). In 1983, *A Nation at Risk* reported that many of the students in the United States were not competitive with international students in their content knowledge, which raised a need for higher academic standards and creating curriculum for gifted students (Hunt, 2008).

In 1988 Congress passed the Jacob Javits Gifted and Talented Students Education Act as part of the Reauthorization of the Elementary and Secondary Education Act. It is the only federal program focused on funding gifted and talented students, though it does not provide support to local gifted programs. Instead it is designed to "orchestrate a

coordinated program of scientifically based research, demonstration projects, innovative strategies, and similar activities that build and enhance the ability of elementary and secondary schools to meet the special educational needs of gifted and talented students.” (National Association for Gifted Children, 2008).

In 2002, No Child Left Behind (NCLB) was passed as the reauthorization of the Elementary and Secondary Education Act. The Javits program was included in this legislation and, while still not providing funding to local gifted programs, it has offered competitive statewide grants encouraging innovation in serving the gifted and talented population of students (National Association for Gifted Children, 2008).

Inter-disciplinary Curriculum and Gifted Students

As early as the 1900's the term “interdisciplinary” education began to be used by the National Council of Teachers of English (NCTE), the definition of which is offered by Burns & Drake (2004):

Correlation may be as slight as casual attention to related materials in other subject areas... a bit more intense when teachers plan it to make the materials of one subject interpret the problems or topics of another.

Fusion designates the combination of two subjects, usually under the same instructor or instructors.

Integration is the unification of all subjects and experiences.

The enhancement of student learning through the use of integrating subject areas into a full-bodied unit has existed for a long time. Students typically find learning that is connected to have more appeal than stand alone subjects. The ability to relate learning to the “real world” and develop a life-long love of learning is greatly enhanced through

projects that are inter-disciplinary in nature (Lapp & Flood, 1994). While this idea has been in practice for more than 100 years, in some format, it began to be popular in the 1990's.

With the onset of NCLB in 2002, changes have been made to the mentality of education where a mastery of basic knowledge has become the focus, which can easily be assessed with standardized testing. This has pushed the creative projects, designed around the knowledge of the basics and further extended, out of the minds of educators in a rush to maximize every moment on the skills needed to test well, as positive performance is tied to school funding (Burns & Drake, 2004). There is greater risk of failing to deliver test results when branching out to a creative type of instruction. The results of student growth can also be more challenging, and subjective, to assess, which is less likely to be relied upon as teachers feel the pressure of having less time to teach and more accountability for student success on standardized testing in fundamental subjects (Bilek, et al., 2012).

Inter-disciplinary education shows connections to real life and unites smaller and larger picture learning in a way that appeals to a wide variety of learners. The smaller picture learning includes the basic content while the larger picture allows for the connection to life, and therefore, seeing learning as something that is not contained within the walls of a classroom, but in the living of life itself. Being able to use this approach with gifted students not only allows them to be able to learn the basic content, but they can then extrapolate this understanding into innovation and self-motivated learning that carries them forward in life (Tanggaard, 2011). By tying creativity into inter-disciplinary education, students learn, engage and explore.

Leonardo da Vinci as a Model

Leonardo da Vinci, a famous painter in Italy during the Renaissance period, serves as an excellent role model for students. Though he is known best for his art, he was also a man of science. He studied the human body extensively, created countless inventions for both practical and fanciful purposes, looked to nature for inspiration and document his thinking and learning through the use of notebooking (Byrd, 2003). He studied astronomy, measurement, architecture, optics, physics, music, botany, mechanics, philology, mathematics, flight, power, stage and drama, military weaponry and strategy, anatomy, water and cartography. His natural desire to learn because of insatiable curiosity and his gifted thinking makes him a natural choice as an inspiration for gifted students. Creating an inter-disciplinary unit with da Vinci's studies as inspiration provides ample opportunity for topic selection for teacher and students.

Proponents of Gifted Education

The need to inspire gifted students brings forward a variety of concerns for those in support of serving gifted students. Funding and consistency issues, social connections and academic achievement are all aspects that must be addressed.

A recent study on the impact of legislation and policies across 5 states on the gifted found that, while included in NCLB legislation, gifted education was not well defined, nor did it have consistency among states (Brown, Avery, VanTassel-Baska, Worley II, & Stambaugh, 2006). The study evaluated document reviews, structured interviews of each state's Department of Education key staff, state staff overseeing gifted programs and deductive analysis of each state program compared to the National Association for Gifted Children standards. The findings indicated that states focused on

the gifted achieving state standards similar to the regular student population since legislation was unclear. There were only 2 states that disaggregated the scores of the gifted from the rest of the student population. Each state had different policies and approaches to teaching the gifted. There was an overabundance of focus on identification of gifted students, rather than implementation of programs to best serve students (Brown, Avery, VanTassel-Baska, Worley II, & Stambaugh, 2006). The implications called for a shift in focus to creating curriculum that focused on challenging the gifted learner in a more consistent way in order to provide student stimulation and increase opportunities for increased funding.

Another area that is of concern for the gifted is their relation to peers. Opponents sometimes state that students that are gifted should be with regular peers so they can properly socialize. Proponents of gifted education have argued that this can be limiting for the gifted, as they feel the need to fit in trumps academic pursuits. A 2011 study in Australia looked at the concept of *forced-choice dilemma*, which forces an academically gifted student to feel that he or she be less academically successful in order to fit in with his or her peer group (Jung, Barnett, Gross, & McCormick, 2011). Those respondents to the questionnaire, 231 students, were submitted for analysis. Of the varied questions asked regarding academic attitudes and peer relationships, the question that received the highest agreement response from gifted students was “I sway between thinking that acceptance by other students is more important than academic success, and thinking that academic success is more important than peer acceptance,” (Jung, Barnett, Gross, & McCormick, 2011). 91% of the gifted students answered that they agreed with the statement. These results were from students that were considered gifted, but were not in a

specific gifted program with peers with similar abilities, which indicates that students struggle with pressure to be similar to their peers, even if that means that they need to appear less intelligent. Students that are grouped with those that are similar in ability tend to have less difficulty with feeling that then need to appear less intelligent to be able to better connect with their peers (Jung, Barnett, Gross, & McCormick, 2011).

Academically, being surrounded by gifted peers allows for student to rise to a higher level of academic achievement. In a study comparing a group of 554 gifted students in urban settings, 72% received gifted services in a clustered group of students at a similar ability of giftedness and 28% received instruction in a heterogeneous classroom. The students in the homogenous groups experienced much higher academic growth in mathematics than those in the heterogeneous groups. Achievement was shown to be similar in growth regardless of demographic factors such as gender, ethnicity, ELL status and grade level (Brulles, D., Cohn, S. & Saunders, R., 2010). This supports the grouping of gifted students with other students of similar ability to increase academic success.

Opposition to Gifted Education

While many recognize that developing talents is important, there has also been an attitude that serving gifted students can sometimes be an elitist endeavor. Part of the issue has been a lack of identification of minority students due to testing that can be considered to be too narrow and racially biased (Franklin, 2007). These students already have advantages and, therefore, some do not see a need for additional services to further separate them from regular students and believe that all students are gifted in their own way (Mildrum, 2000). A study examining 3 different types of testing designed to incorporate multiple intelligences shows that students are intelligent to different degrees

in different areas. The data were analyzed from 2 different elementary schools and showed that students tested showed a better balance of ethnicities and socio-economic status when a focus on different types of intelligence is weighed (Kornhaber, 1999). In testing, children identified by one of these types of tests, were identified as needing to be considered for gifted education at a rate 15% higher than previously recommended from typically marginalized groups, suggesting that the general population of students shows areas of giftedness.

The development of Gardner's Multiple Intelligences, which includes identifying different types of intelligence such as linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, intrapersonal and naturalist, has been used to support the thought that each person has intelligence in different ways and in varying degrees of each type. Incorporating the different types of intelligence into account allows for many more students to be identified as gifted, whereas the number, previously, would have been smaller (Kornhaber, 1999). The case is made that each student is gifted in different ways and that students should remain in environments where their talents are shared with a heterogeneous grouping of classmates to ensure that all are challenged and have opportunities to develop different types of creativity together (Mildrum, 2000).

A summation of 12 studies looking at the structure of cooperative grouping of gifted students with homogeneous grouping and heterogeneous mixed-ability grouping found that all students benefitted from heterogeneous grouping, with the data showing that positive changes occurred in both achievement, self-esteem and social competence (Finsterwald, Neber & Urban, 2001). The results were significantly more positive in the lower-ability students in these studies, showing the gifted students benefiting less, though

still having a positive impact. Additionally, another study included 229 highly gifted students and 557 non-highly gifted students working in heterogeneous mixed-ability groups and found that academically the gifted students performed about the same when working alone versus working in the group, but had much higher social outcomes, being regarded as friendly and better leaders (Finsterwald, Neber & Urban, 2001).

Another issue that arises in opposition to gifted education is funding. Since there are wide variations between what is defined as “gifted” and funding is not offered at a district level, but through competitive grants at the federal level only, school districts struggle to pay for an education that is best suited to gifted students needs (National Association for Gifted Children, 2008). Often a pull out model is relied upon where students are taken out of the regular classroom and instructed by an enrichment teacher for 30 minutes to 2.5 hours per week. By not adequately funding gifted education, many students are left being underserved and since they meet state testing requirements, much of the time, they are not viewed as a main focus of NCLB because no additional funding will be awarded if these students succeed beyond what state testing measures (Levy & Palley, 2007). A study evaluating the expenditures of various states in the United States on gifted education shows that there is no uniformity in the allocation of funds for gifted students and programs, with amounts set aside for gifted students typically being much less than what is set aside for other special education students (Baker & McIntire, 2003). Some allotted extra funds based on pupil weights (ranging from .12 in Texas to .64 in Georgia), flat-grants (ranging from \$55 per student in Arizona to \$320 in Washington), with limitations of the number of pupils that can be eligible (ranging from 2% in Washington to 5% in Texas). Another method, resource-based funding, is used by some

states to aid in staffing gifted programs, each with varying formulas, but they do not limit the percentage of students that can be classified as gifted, unlike the limitations in other states, such as Washington state (Baker & McIntire, 2003).

Multicultural Issues in Gifted Education

From the onset of intelligence testing, issues with cultural insensitivity arose early on. The Binet-Simon Intelligence Testing (IQ testing) was first used to test students thought of as deficient learners, including African-American, Mexican and Native American students (Franklin, 2007). The tests were defined as being too narrow and catered to white, middle class students. The difference in environment, including lack of adequate learning materials in segregated schools, and other socio-economic factors have proven that students with similar abilities may perform less favorably on standardized testing (Franklin, 2007). The passing of Brown vs. The Board of Education ended separate but equal education and this began progress towards making the scholastic experience more unified for all students. In 1964, the Civil Rights Act passed, which made equal opportunities for all in the area of education, among others, a legal right (National Association for Gifted Children, 2008).

White students continue to be identified disproportionately higher than those from other cultural backgrounds, but this is recognized and attempts are being made to make certain that students from other cultures, or less-advantaged backgrounds, are not neglected though traditional IQ testing and other standardized testing that may not adequately show their abilities.

The Jacob Javits Gifted and Talented Students Education Act encourages the teaching of gifted curriculum to regular classrooms and specialized teacher training in

order to serve all students. Additionally, the use of programs such as Georgia's Jarvis funded "multiple-criteria eligibility model" encourage the composite of mental ability, composite achievement, total reading and total math scores to define the "gifted." In these, exceptional talent in any one area is weighed, but also general talents. There has been a significant increase in the number of identified students from a variety of cultural backgrounds since the implementation of this method of identification (Krisel & Cowan, 1997).

Assessment

Assessments for the project include rubrics measuring application of learning extended into a finished product. These products will be a mixture of teacher-directed and student-designed, allowing creativity and innovation within the context of content area goals. Rubrics will measure students' work using a 1-4 rating, which are defined based on the lessons and included in the appendix.

Summary

From early on in the United States educational system, gifted people were seen as having value in the field of innovation for the betterment of the country. Through the development of IQ testing, the gifted were easier to identify in the early 1900's, however there was no funding available to support gifted education. The introduction of the Jacob Javits Gifted and Talented Students Educational Act awarded federal funding to gifted education and the introduction of NCLB solidified the future of gifted education funding.

Due to the focus on state standard assessment achievement, many gifted students have not had the opportunity to learn using inter-disciplinary, project-based learning, which allows for their creativity and innovation to be showcased. Leonardo da Vinci

serves as a model of unique, interconnected thinking that can inspire gifted students to go beyond the basic instruction taught in many classrooms. While gifted education does receive some federal funding, much of the focus has been on the identification of gifted students, not on how best to teach them.

While recognizing that the gifted students, when working together, can push each other to grow at a higher rate academically, some oppose gifted education as an elitist endeavor that robs average students of the opportunity to be encouraged by advanced thinking offered by gifted students and gifted curriculum. Opponents also argue that gifted students fair better socially when kept in a standard classroom.

CHAPTER III

Background of the Project

The project was created after investigating Leonardo da Vinci's varied studies and evaluating how his inter-disciplinary style of learning could connect to the classroom setting. Research was done to find project ideas that authors had written about that might provide inspiration for lessons. Ideas were selected and modified, or created from new, and taught in several classrooms to evaluate for effectiveness and areas for improvement. Once they had been tested, formal lesson plans were written and designed to be taught by other teachers. The modified lessons were taught by the creator of the lessons or other teachers. Feedback was gathered and modifications to the lessons were made, as needed.

Project Procedure

First, a thorough investigation of the life studies of Leonardo da Vinci occurred. Then connections to the curriculum were identified in art, math, science, communication and writing. Lesson ideas were generated and tested in push-in classes in local elementary schools. Once tested, reflective analysis and modifications of the lessons were done. The modified lessons were then taught by the designer of the lessons or other teachers to be tested for any additional modifications that were needed.

Project Development

The development of the project began from an idea inspired by the learning style of Leonardo da Vinci, including extensive notebooking, and his varied interests in different topics. The Washington State K-12 Learning Standards were examined to identify how the ideas presented by da Vinci, or those that studied him, could be connected to academic learning targets was completed. Once these were incorporated,

informal lessons were created and tested in local elementary schools. Any issues that arose were addressed before the formal lesson plans were taught. After being taught by the lesson creator, or other teachers, feedback was gathered to make additional modifications before the final lesson plans and assessments were written.

Project Implementation

The project will be used by teachers teaching in gifted programs, for students in 4th and 5th grades. It can be modified for students in other grades, used in the regular classroom or used in summer enrichment programs, as well. The lessons have been tested in classrooms with students of varying abilities in giftedness.

CHAPTER IV

Summary of the Project

The project begins with its roots in a children's literature book, "Leonardo Beautiful Dreamer," by Robert Byrd. The teacher begins by reading the book and noting the areas of da Vinci's life that might be of the most interest to students, with thinking of a framework of presenting him with his natural curiosity and diverse interests as inspiration. The students create a notebook to record their own ideas, as modeled by Leonardo da Vinci. They will use these notebooks throughout the course of study, as determined by the teacher.

A lesson on 3-D perspective in art, connected to mathematics, follows, reviewing shape attributes, introducing vocabulary and reinforcing previously learned vocabulary. Students learn art appreciation in da Vinci's "The Last Supper" in addition to the vocabulary, including the visual tricks da Vinci uses to entice the eye. These techniques are then used in a student drawing and students experience painting using natural materials that they grind up with a mortar and pestle.

A week-long experience with pageantry and mask-making (inspired by da Vinci, as he often was in charge of parties for his royal employers) including writing scripts and performing theatrical productions, is included, allowing students to work cooperatively in groups to inspire each others' creativity. Paper mache technique is used and completed through painting of the masks.

Another lesson, taking more than one day, involves learning about topographical maps, which da Vinci created for his employers' military needs for defense and attack. Students study a variety of topographical maps and use one as a model (or create their

own world) to craft a topographical map out of salt dough, which is then matched to scale from drawing to mini-salt dough map and painted for display.

Using da Vinci's sketch of "The Vitruvian Man," students study measurements of the human body, learning about the proportions of man discovered by roman architect, Vitruvius, and further studied by Leonardo da Vinci. Students are able to test their own ideas in their classrooms.

Da Vinci also had a passion for flight. Students will study some of his flight machines and build a helical air screw, resembling one of the da Vinci's inventions. They will learn about torque and lift in the context of building the helical air screw.

The final lesson teaches about surface area and the balance of weight on student-created walk-on-water shoes. Students will learn that adequate surface area and balance of weight are key to keeping a person afloat on these shoes.

Finally, assessments are included to ensure that learning is focused on extending past state standards into the realm of creativity and application.

CHAPTER V

CONCLUSIONS

The project was designed to encourage creative thinking that extended beyond the basic Essential Academic Learning Requirements for the state of Washington to involve students applying what they learn to new contexts or student-designed projects. Having students work together in homogenous groups, with students that are of like ability, should encourage students to not hold back academically in order to preserve peer relationships (Jung, Barnett, Gross, & McCormick, 2011).

Students that are gifted do not often receive adequate instruction because the allocation of funding does not legislate it in a way that states have to provide a uniform amount for gifted programs, nor is the curriculum for gifted students unified across states (Baker & McIntire, 2003). Because of the inequity, many gifted students are in regular classrooms without the clustering of minds that can push their learning to go further. There is some support that heterogeneous grouping can serve gifted students socially, though their academic performance is not as different as it would be working alone (Finsterwald, Neber & Urban, 2001).

IMPLICATIONS

This project will be used by 4th/5th gifted education teachers in self-contained gifted classrooms, although it could be modified for use with other grade levels. It can also be used as part of a summer enrichment program for students. The project can be further extended by examining more of Leonardo da Vinci's notebooks in order to create lessons in math, art and science that inspire student creativity while teaching basic skills required by the state.

RECOMMENDATIONS

For further research, looking at changing the focus from standard-based assessment to creative output and how that change impacts performance on state standards for the gifted would provide valuable insight about what to value- content knowledge or knowledge application. Measuring student attitudes and thoughts on learning in relation to having an experience where their creativity was valued over all else might show a change in motivation.

The project itself could be added to with additional lessons connecting math, science, literacy and art to specifically align with district standards, looking at other aspects that Leonardo da Vinci studied to connect with in their development. It could be adapted up or down in grade level and other lessons could be created to align with the abilities of students in other grade levels.

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CREATIVE MULTI-DISCIPLINARY LEARNING INCORPORATING DA VINCI-
STYLE THINKING FOR GIFTED STUDENTS

Project by Amelia Melissa Ferrell

Introduction to Da Vinci-Inspired Lessons

In the interest of making this handbook a useful tool, it is important to note that the lessons are not designed to be used in sequential order, but as easily fits into the current curriculum as an infused unit, however you do need to begin with lesson 1 to give the unit a coherent start and an adequate jumping off point. Some lessons are to be conducted over several days. A few activities do ask for materials that are atypical and more costly than typical teaching materials, such as the walk-on-water shoes, but many materials can be borrowed. For the other items, I suggest presenting a summary of the unit to the Parent-Teacher-Student Association or apply for an arts grant in your community. Assessments are provided at the end of the handbook.

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Lesson 1: Who was Leonardo da Vinci? Notebooking a Genius

Supplies: A copy of the book, “Leonardo: Beautiful Dreamer,” by Robert Byrd, watercolor paints for each pair of students, paintbrush for each, pre-stapled notebooks with construction paper (or ideally, watercolor paper) cover and plain paper inside (folded in half), water cup to share with each pair of students, copy of “Leonardo’s Notebooks,” edited by H. Anna Suh, pencils

Key Essential Academic Learning Requirements (EALRs) for Washington State:

Art EALR 4: The student makes connections within and across the arts (dance, music, theatre, and visual arts) to other disciplines, life, cultures, and work.

Writing EALR 2: The student writes in a variety of forms for different audiences and purposes.

Communication EALR 1: The student uses listening and observation skills and strategies to gain understanding.

Social Studies EALR 4: HISTORY The student understands and applies knowledge of historical thinking, chronology, eras, turning points, major ideas, individuals, and themes of local, Washington State, tribal, United States, and world history in order to evaluate how history shapes the present and future.

1. Share the book “Leonardo: Beautiful Dreamer,” after reading it yourself as prep.

Use each page to take a walk through the story of da Vinci’s life and studies (tell a condensed version with the highlights). Some pages are best to skip past, but

that is up to the discretion of the teacher. Emphasize his natural curiosity and wonder, plus his approach to recording his ideas and thoughts in a notebook and his varied interests.

2. Show some individual sketches from da Vinci's notebooks entitled, "Leonardo's Notebooks," edited by H. Anna Suh. Show an example of architecture, the human body, The Vitruvian Man and others that impress you. Be sure to show one of his maps for future reference.
3. Have the students go outside with a blank pre-stapled notebook and pencil. Talk about how da Vinci would sketch movement. What movement can they see? Talk about the basic shapes found in objects. Have students sketch the cover they wish to watercolor on their notebook covers (something natural).
4. Once inside again, offer reminders about how to properly use watercolors (rinsing in between colors, etc). Have the students paint their notebooks.
5. For the unit, ask them to record their ideas, thoughts, noticings, or anything else they wish that is born from curiosity in the notebook. Let students know they will be sharing them with each other.
6. Each day that week, ask for students to share out something they've recorded in their notebooks with a partner. Offer times to sketch 1-2 times a day when you need a transition activity.
7. On the last day of the unit have all students bring their notebooks to share. Allow ample time for students to look through and question each other.
8. Be sure to discuss what they noticed about their own preferences and what learning they have from the experience.

9. Ask students to find, or create, an alternative way to accomplish the capturing of their ideas using technology.

Lesson 2: 3-D Perspective and “The Last Supper”

Supplies: Poster of Leonardo da Vinci’s “The Last Supper,” rulers, paper, pencils, paintbrushes, eggs, bowls, mortars and pestles, spices and dirt, plastic spoons, Dixie cups

Key Essential Academic Learning Requirements (EALRs) for Washington State:

Art EALR 1: The student understands and applies arts knowledge and skills in dance, music, theatre, and visual arts.

Art EALR 2: The student uses the artistic processes of creating, performing/presenting, and responding to demonstrate thinking skills in dance, music, theatre, and visual arts.

Math EALR 4: The student communicates knowledge and understanding in both everyday and mathematical language.

1. Explain that they will now learn to use horizon lines, vanishing points and orthogonal lines using a ruler and paper after learning about these things through the example of Leonardo Da Vinci’s “The Last Supper.” After they draw some shapes that they make 3-D, they’ll practice early painting techniques using a mortar and pestle and grinding up natural materials that they’ll mix with egg yolks to paint. This egg tempera paint was used before oil paints, though most Renaissance painters used oil.
2. Show students the poster of “The Last Supper” and mention that da Vinci used certain types of lines and techniques to create depth in his painting.

3. Discuss the subject of the painting and significance of “The Last Supper.” Share that it is painted on the wall of a monastery in Milan, Italy.
4. Ask students to look down at the floor (or desk) and then to look up at the painting. What is the first thing that they notice? Where does the eye naturally go (should be Jesus, in the center)?
5. Point out the horizon line in the center of the painting, which runs right through the middle of Jesus’s head. The horizon line is where the earth meets the sky.
6. Discuss that Jesus is also centered, which draws the eye.
7. Finally, point out the orthogonal lines in the painting (these are the lines that connect to the vanishing point, which create the illusion of 3-D). In this case the vanishing point is Jesus’s head. Show how the lines along the tapestries and in the ceiling all meet at the vanishing point in the painting.
8. Have them get out a paper, pencil and ruler. Model each step on a whiteboard or on the document camera. Have them lay the paper horizontally, as a landscape.
9. Draw the horizon line in the middle to make a landscape. Have students do the same using the ruler (they will use it for each straight line). Review vocabulary throughout the lesson (attributes of the shapes as well).
10. Add the vanishing point about in the center of a line. Make a small dot.
11. Pick a corner (bottom right, for example) and have the students make a triangle after you model. Instruct them that you will be adding the orthogonal lines, connecting the corners (vertices) of the triangle to the vanishing point, but only the corners that will not cross over the shape. Tell the students to use a light line because they will be erasing part of it.

12. Once that is done, review what a parallel line is and show lining up the ruler on the side of the triangle that is between 2 orthogonal lines. Show them how to slide the ruler out, evenly, so that you can sketch in a line parallel to the side, connecting the 2 orthogonal lines. Talk about the visual effect as a class.
13. Erase the rest of the line past where the parallel was added to the vanishing point.
14. Use the same technique to draw a square, rectangle and an oval, but model a curved parallel line after adding orthogonal lines to the edges of the oval. As you make each shape, note what it looks like in phases. For example, the rectangle looks like a skyscraper when the orthogonal lines are first put in and the oval looks like a spotlight (or a Bat signal).
15. Challenge students to use the same techniques on the back of their papers to show an extension of their learning with other shapes.
16. Discuss that da Vinci used a different type of paint for “The Last Supper” that has not held up well over the years and that most Renaissance painters used oil paints. Prior to that, some used an egg tempera paint, which is made from the yolks of eggs. It dries too fast for most artists’ preferences and needs to be painted in layers that dry in order to achieve depth of color.
17. Model for students how to separate an egg white from the egg yolk by cracking it in the center and pouring the yolk back and forth over a container to drain off the white, reserving the yolk in the Dixie cup.
18. Have the students work with the mortars and pestles to grind up different spices and dirt to serve as a tint for their egg yolk tempera paint. Colorful spices are dill,

curry and paprika. Have them add one spoonful of natural material to each egg yolk in the Dixie cup and mix with plastic spoons, once ground down.

19. Paint with the egg yolks, having students trade colors, as desired.
20. What else could they use to color their paints? Can they come up with other materials to make a different type of paint? Test and try any that sound feasible.

Lesson 3: Pageantry and Masks

Supplies: Day 1: A copy of the book “Leonardo: Beautiful Dreamer,” by Robert Byrd, mask bases (ask an art teacher to borrow), gallon of glue, big bowls, water, newspaper strips about 1x6 in size, cardboard, paper towels Day 2: Tempera paints, paint brushes, glue, decorative supplies (like feathers, buttons, sequins, etc.), hole punch, thick string

Key Essential Academic Learning Requirements (EALRs) for Washington State:

Art EALR 1: The student understands and applies arts knowledge and skills in dance, music, theatre, and visual arts.

Art EALR 2: The student uses the artistic processes of creating, performing/presenting, and responding to demonstrate thinking skills in dance, music, theatre, and visual arts.

Writing EALR 2: The student writes in a variety of forms for different audiences and purposes.

Communication EALR 2: The student uses communication skills and strategies to interact/work effectively with others.

1. Remind students about Leonardo’s theatrical side by revisiting the section of “Leonardo: Beautiful Dreamer” addressing it. Discuss his robotic lion and the royal pageants he put on.
2. Have students discuss, in table groups, a story they’d like to create masks for and perform together. They could use classic fairy tales as inspiration, pick a familiar

story to the class to reenact or create their own tale, depending on the group's preferences.

3. Once they've decided, have them start the construction of their masks with paper mache. Using a big bowl per group, mix 1 c. of glue to 1 c. of water. Dip strips in the mixture and drain the excess glue off by running the entire strip between your pointer and index finger. Layer the strips over the mask base and use cut up pieces of cardboard to make thicker points on the masks, such as bumps and horns, that you layer more paper mache over the top of to adhere it to the mask.
4. Clean up and then have students return to their groups to begin writing a script to have their characters act out. Work on these as needed until complete. Focus on setting, character, plot, sequence of events and/or dialogue, as desired.
5. Day 2: Have students begin rehearsing their script.
6. Allow table groups to each have paints and paintbrushes, glue and decorations at their tables. Go over how to use the materials properly and then allow students ample time to paint and decorate their masks.
7. Once the masks are dry, use a hole punch to cut out a place to tie the string near each ear. Secure string in each hole with length that will allow for tying around the head.
8. Rehearse with masks and then perform the tales in front of the other groups.
9. Do the students have ideas for using these techniques to create more elaborate masks? Do they have an idea for creating a new play using the masks already created? Could they create a set and props as well? Use their ideas to decide, as a class, how to extend this experience into something they are excited about doing?

Lesson 4: Topographical Maps

Supplies: Copy of “Leonardo’s Notebooks,” edited by H. Anna Suh, topographical maps of local area (use Google Images to locate) plus the USA and Italy, salt, flour, water, cream of tartar, 10” x 10” pieces of cardboard for each student, large sheets of white paper, pencils, measuring tools, bowls, pots, wooden spoon, cardboard 10”x10” squares for each student, tempera paint (brown, blue, green, white)

Key Essential Academic Learning Requirements (EALRs) for Washington State:

Art EALR 2: The student uses the artistic processes of creating, performing/presenting, and responding to demonstrate thinking skills in dance, music, theatre, and visual arts.

Social Studies EALR 3: GEOGRAPHY The student uses a spatial perspective to make reasoned decisions by applying the concepts of location, region, and movement and demonstrating knowledge of how geographic features and human cultures impact environments.

Math EALR 2: The student uses mathematics to define and solve problems.

Math EALR 5: The student understands how mathematical ideas connect within mathematics, to other subjects.

1. Share that one of the ways that Leonardo served the kings he worked for was by helping them with their military planning. He designed weapons and created maps. He walked the land and streets to construct his maps and they were known to be very accurate.

2. Show the students examples of da Vinci's mapmaking from "Leonardo's Notebooks." Allow them sufficient time to appreciate the aerial view. Discuss the topography of them, showing the depth and features of the land.
3. Pass out the various maps of the different countries and local area. Have students discuss the features of the maps. What are the commonalities? Differences?
4. Ask students to think about what type of mapping project they might want to do after you inform them that they will be making salt dough that will dry into a very hard topographical map. They will be able to paint it once it is dry (although it can be painted while wet).
5. When presenting this challenge to students, allow them to think as creatively as possible. The area they map could be realistic or fictional, but the goal is to have students create a 3-D map that shows accuracy from a 2-D map or a drawn sketch.
6. Discuss the concept of "scale" and that the assessment will be partly about the accuracy as described before. Have them think about if they want to make their sketches to map ratio be 4:1, 3:1 or 2:1. Allow them to use measuring tools to help them visualize. Demonstrate and explain, as needed.
7. Have them sketch their map ideas on the large white paper. Have them color it showing the height and features. Once complete, have them sketch the lowest point on the map on the 10" x10" cardboard, providing an outline for the layout of their maps. Be sure to remind them of scale.
8. In pairs, have each student put 4 cups of flour, 1 cup of salt, 1-1/2 cups hot tap water, 2 tsp. cream of tartar in a bowl and mix until it becomes elastic. Knead the dough.

9. Have the students divide the dough between them and make their maps out of the dough, being sure to create the features accurately according to their sketch.
10. Once the maps are complete, allow them to dry until the next day to paint. You can wait longer, but it is acceptable to paint the maps when they are still wet.
11. Have the students write up a description, including their use of scale, and display those along with the maps and sketches.

Lesson 5: Measurement and the Vitruvian Man

Supplies: A poster of “The Vitruvian Man” by Leonardo da Vinci (can cover the genitalia, if deemed necessary), measuring tapes (one per pair), butcher paper (pre-cut in a section longer than their height of the students, 1 for each student and additional sections, this time 1 for each pair, the same length. Cut down the length to create the arm span), washable markers, copy of “Leonardo’s Notebooks,” edited by H. Anna Suh, tape

Key Essential Academic Learning Requirements (EALRs) for Washington State:

Math EALR 1: The student understands and applies the concepts and procedures of mathematics.

Math EALR 2: The student uses mathematics to define and solve problems.

1. Show students the poster of “The Vitruvian Man” and point out the circle and the square that touch the outstretched fingers and show the height of the man. Share that this sketch is how da Vinci expressed the ideas of the Roman architect and engineer known as Vitruvius. Vitruvius noted that the height of a man was equal to the reach of his arms from fingertip to fingertip. Da Vinci was inspired by this work to do further studies on the proportions of the human body.
2. Explain that the students will use this same idea to sketch their own bodies using butcher paper. Explain that you want them to be very careful to outline the body closely so the knees and elbows show (also provide guidance about avoiding private areas of the body, they can just skip that part and fill it in once the child moves).

3. Have the long wide sheet be the base and lay the arm piece down crosswise.
Have students lay down on the papers to be sure they are in the proper position.
Once correct, tape the sections together.
4. Have the students use the markers to do the tracings. Once complete, have them use the measuring tapes to compare their height to the width of their outstretched arms. How do they compare?
5. Once that is complete, share that da Vinci did many studies on the human body and explored many other interesting measurements. Some others that this sketch can show are: the distance from the elbow to the fingertips is $\frac{1}{4}^{\text{th}}$ of the height of a man, the distance from the elbow to armpit is $\frac{1}{8}^{\text{th}}$ of a man's height, below the foot to the knee is $\frac{1}{4}^{\text{th}}$ the height of a man. Some other explorations that can be done using the tape measure are: the length from the hairline to the bottom of the chin is $\frac{1}{10}^{\text{th}}$ of a man's height, below the chin to the top of the head is $\frac{1}{8}^{\text{th}}$ and the foot is $\frac{1}{7}^{\text{th}}$ of the height of a man. Have them write out the measurements and comparisons on the butcher paper.
6. There are many more proportions to try, but after exploring these, allow students to investigate any other measurement ideas on their own. Allow them to test their ideas with the class. Have them analyze the data on the differences, in inches, using range (difference between largest and smallest values), mean (usual average), median (the middle value) and mode (number repeated more often than others) to determine to see if their ideas were valid or not.

Lesson 6: Flight and Lift, Creating Corkscrew Helicopters

Supplies: A copy of the book “Leonardo: Beautiful Dreamer,” by Robert Byrd, cardstock, scissors, mechanical compasses, pencils, chopsticks, masking tape, cardboard, duct tape, hammers and nails, 3 1” x 1” x 6” pieces of wood for each student (1 should be drilled all the way through with an electric drill bit that is a bit bigger than the chopstick, 1 should be drilled half way through and make sure that the holes the same distance from the ends of the wood), string

Key Essential Academic Learning Requirements (EALRs) for Washington State: Science EALR 2 Inquiry is the bedrock of science and refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how the natural world works. Students ask and answer questions that facilitate growth in their understanding of the natural world. Inquiry includes the idea that an investigation refers to a variety of methods that can be used to answer a scientifically oriented question, including: systematic observations, field studies, models and simulations, open-ended explorations, and controlled experiments.

1. Share the excerpt from “Leonardo: Beautiful Dreamer” about Leonardo da Vinci’s passion for flight. Show them the picture of the corkscrew style of helicopter that da Vinci invented.
2. Do they believe that it would have actually flown? Allow them to discuss. It wouldn’t be powered as da Vinci envisioned, but the corkscrew design does have merit.

3. Have students begin by using a mechanical compass to create 2, 7-1/2" circles.
Explain how to use the compass.
4. Poke a hole in one of the circles and push the chopstick through it. Cut the circle halfway through. Cut the other circle half way through, as well, and tape one half of it to the other end of the other circle on the chopstick.
5. Bend the upper part of the top circle up and add a length of tape from the top of the chopstick to the upper part of the circle to continue the airflow.
6. Twist the air screw around in the air to get a sense of if it is balanced on both sides. If not, add a bit of tape to the bottom of the lighter side to balance it.
7. Cut out 2 cardboard circles (about 2" in diameter, review diameter vocabulary) and stack them together. Cover them with duct tape to join and add weight.
8. With a hammer and nail, make a hole in the center of the cardboard discs.
Enlarge the hole enough to snugly fit the chopstick into it. Leave about 3" of chopstick below the bottom of the discs.
9. Have the students stack the 3 pieces of wood in this order: pre-drilled hole all the way through on top, solid wood in the middle (but pushed back 2" behind the end of the wood with the hole), hole half way drilled through on the bottom at the same position as the top piece. Nail together using 3 nails.
10. Put the helical air screw through the holes in the wood base (launcher), with the circular cardboard base resting on the top piece of wood. Wind the string in between the top and bottom parts of the launcher and pull to launch (do outside with space between kids).

11. Discuss why it works and what would happen if it had a constant power source as opposed to one that will only last for a short time. How could it be powered?

Challenge students to develop their own flying machine. Can da Vinci's ideas in flight inspire them to try creating something that flies? Have students sketch their ideas in their journals.

12. Using these ideas, offer the students material used in the project, or other things that might make building their ideas possible. Build and test their inventions.

Lesson 7: Water Shoes, Surface Area and Floating

Supplies: A copy of the book “Leonardo: Beautiful Dreamer,” by Robert Byrd, 2 pieces of Styrofoam “blueboard” insulation- 3” thick and 2’ X 8’, yardstick, rulers, measuring tape, pencil, large serrated knife, pen, duct tape, scissors, 2 broom handles (or other long sturdy wood pieces like a dowel, but similar in size to a broom handle), inflatable pool at least 10’ in length, hose with water source, towels and a change of clothes, clipboard and pencil to record data

Key Essential Academic Learning Requirements (EALRs) for Washington State: Science EALR 2 Inquiry is the bedrock of science and refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how the natural world works. Students ask and answer questions that facilitate growth in their understanding of the natural world. Inquiry includes the idea that an investigation refers to a variety of methods that can be used to answer a scientifically oriented question, including: systematic observations, field studies, models and simulations, open-ended explorations, and controlled experiments.

1. Share the excerpt from “Leonardo: Beautiful Dreamer” about water. Discuss da Vinci’s love of water, including movement and powering abilities. Share about some of the inventions that da Vinci created in association with water. Be sure to discuss his admiration of animals reflected in his inventions.
2. Tell the students that you will be building, and testing, 2 pairs of walk-on-water shoes that are inspired by da Vinci’s creation. The class will make one shorter

pair and one longer pair. Ask if they have any predictions about whether the length of shoes will matter or not. Discuss as a class and direct the students, eventually, to the idea of surface area making a difference in supporting the weight and height of a person, if they don't arrive there on their own.

3. Measure the tallest student and the shortest student in the class and cut each piece to the same height (take turns with students helping with each step). Save the leftovers for later. Please note that each step is to be applied to BOTH the shorter and longer pieces throughout the remaining instructions.
4. Cut each piece lengthwise so you have 4, 12" pieces.
5. Measure to find the middle of each piece of blueboard at an end and mark it. Measure back 8" on both sides of each piece and sketch a line connecting the end middle point to the side point 8" back. Cut the parts off of the board so part of the board looks like a ski. These pointed ends will be the front of the walk-on-water shoes.
6. Have the students use rulers to measure out strips of duct tape to make pockets that will be attached to the bottom of the water shoes to fill with water as the rider propels forward, allowing for adequate friction to keep up momentum. For each shoe, have students cut a 4 sets of strips 4", 5", 6", 7", 8" and 9". Overlap the strips, sticky side up, by about $\frac{1}{4}$ th of an inch on top of each other, creating what looks like a pyramid. With the 4" strip being at the top with nothing attached to it, start adding shorter strips, stick side to sticky side on the layers below the top one. For example, the 9" strip will have a 7" strip added to it (again sticky side to sticky side), centered. Work up each layer, adding tape in the following order: 6",

5", 4" and 3". If layered correctly, there will be a sticky surface exposed on the top and sides to attach to the bottom of the water shoes.

7. Attach the 4 pockets for each shoe to the bottom in a staggered fashion like footsteps (starting the first one about 5" back from the top of the water shoe and have the last one be just a little over half way down the shoe), but attach them with some slack (big enough for a hand to slide into) to allow for the water to flow inside.
8. Using the same pyramid-style pocket, make the foot pockets for the top of each of the water shoes. This will be a larger pocket using duct tape measurements of 4" to 11" with the sticky side up. Then cut the smaller strips to attach sticky side to sticky side measuring in length from 3" to 9" centering the shorter pieces to allow a sticky side on the top and sides of the pocket.
9. Mark the spot to attach the foot packets by marking halfway down the length of the shoe. Align and center the top of the pocket on this mark, but be sure to allow slack to allow for the size of the foot when attaching.
10. Reinforce each of the areas where the pockets are attached with a long strip of duct tape on each side. Keep extra duct tape on hand for repairs when testing with the entire class.
11. The class will need to make only one set of poles. Use the leftover blueboard to cut out 2 6" x 6" squares. Insert a broom handle into the center of each one. Reinforce the attachment with duct tape. These poles will help the walk-on-water goers with balance.

12. Outdoors, inflate and fill the pool with water from a hose. Have students carefully slide their feet into the water shoes with support from spotters and enjoy trying out both sets of shoes. Record the height of each student and the success with each set of water shoes, measured by whether the shoes kept them afloat or not (weight supported).
13. Afterwards, analyze the data and see if the length of the shoes (added surface area) matters depending on the size of the students. What conclusions do they have?
14. Challenge the students to make sketches in their journals of other types of water inventions. Have them include materials they would need and think about whether their invention is scientifically sound. Have them share with the class.

Lesson 1 Assessment

	4	3	2	1
Journal Entries	Minimum of 6 sketches. Most sketches show thought and creativity.	Minimum of 5 sketches. Some show thought and creativity.	Less than 5 sketches or sketches do not show thought or creativity.	Less than 5 sketches and sketches do not show thought or creativity.
Journal Cover	Painted with a natural inspired setting.	Painted and complete.	Painted, but not complete.	Unpainted.

Lesson 2 Assessment

	4	3	2	1
Cooperative Teamwork	Worked well with others, contributed to the team	Had some issues getting along, but contributed	Had some issues getting along and contributed minimally	Issues getting along and made almost no contribution
Creativity	Thoughtful, unique ideas, meshing with other group member ideas	Thoughtful ideas that meshed well with other group members	Ideas showed some thought or originality, but didn't contribute to the group	Little thought or originality and disconnected to the group
Script Contribution	Dialogue and scene settings were contributed to to create script	Either dialogue or scene settings were contributed	Ideas were contributed to construct the dialogue or setting	No script contribution was made
Performance	Mask matched acting of character and character aligned with script	Mask matched the character	The mask seemed somewhat disconnected	The mask had nothing to do with the character or script
Extension Activity	Developed idea showed creativity and originality and was executed well	Idea showed creativity and originality and was executed adequately	Idea lacked creativity or originality or was executed poorly	Idea lacked creativity and originality and was poorly executed

Lesson 3 Assessment

	4	3	2	1
Cooperative Teamwork	Worked well with others, contributed to the team	Had some issues getting along, but contributed	Had some issues getting along and contributed minimally	Issues getting along and made almost no contribution
Script	Wrote a sizeable portion of the script and was helpful with other students in their writing	Wrote a sizeable portion of the script	Contributed some to the script	Wrote very little of the script
Mask	Mask was constructed according to instructions, showed creativity and solid execution	Mask was constructed according to instructions, showed some creativity	Mask was constructed according to instructions	Mask did not reflect instruction
Performance	Performed with energy and enthusiasm, memorized script	Performed with energy and enthusiasm	Performance had some energy and enthusiasm	Little energy or enthusiasm in performance

Lesson 4 Assessment

	4	3	2	1
Topographical Map Construction	Map was formed to show features and height of plan with painting enhancing the understanding of height and features	Map was formed to show features and height of desired area and was painted	Map only somewhat reflected the plan and is painted	Map did not reflect plan and/or was not painted
Plan	Showed outline of land and important features. Was colored to reflect height and area features	Showed outline of land and important features and was colored	Showed outline of land and features	Showed outline of land
Scale	Scale was used in a way that the plan very closely matched the created map	Scale was used in a way that the plan closely matched the created map	Scale was used in a way that the plan somewhat resembled the map	Scale was not evident in the transition from plan to map.
Description	Explained the land including features and height differences, included description of how scale was used	Explained the land including features and included description of how scale was used	Explained the land including features OR included description of how scale was used	Did not explain the land features or scale

Lesson 5 Assessment

	4	3	2	1
Cooperative Teamwork	Worked well with others, contributed to the team	Had some issues getting along, but contributed	Had some issues getting along and contributed minimally	Issues getting along and made almost no contribution
Measurements	All measurements were completed and reflected, including comparisons, on the butcher paper	Most measurements were completed and reflected, including comparisons, on the butcher paper	Some measurements were completed and reflected, including comparisons, on the butcher paper	Few measurements were completed and reflected, including comparisons, on the butcher paper
Ideas	Ideas for other measurements, using the human body, were explained and tested	Ideas for other measurements, using the human body, were explained	Ideas for other measurements, using the human body were partially explained	Ideas were not explained

Lesson 6 Assessment

	4	3	2	1
Constructed	Helical Air Screw was constructed according to instruction and modifications were made to enhance flying based on balance	Helical Air Screw was constructed according to instruction	Helical Air Screw was constructed, but missed some steps	Helical Air Screw did not follow instructions
Investigation	Able to explain how the air screw works and shows an understanding of balance, friction and energy	Able to explain how the air screw works and shows an understanding of balance, friction OR energy	Able to explain some of the concepts of how the air screw might work	Does not show thought to explain how air screw works
Self-developed project	Project idea shows an extension of the learning into a creative idea that should work, materials are listed	Project idea shows an extension of the learning into a creative idea that may work, materials are listed	Shows an extension of learning, but is unclear about if it will work and how	Idea does not connect to learning

Lesson 7 Assessment

	4	3	2	1
Participation	Assisted in the building of the water shoes and participated in a positive manner	Assisted in the building of the water shoes and participated in a positive manner most of the time	Assisted in the building of the water shoes, but did not work well with others	Offered little assistance to build water shoes
Recorded and analyzed data	All data from each classmate on both sets of shoes were recorded. Data were analyzed to find connections to size of student and size of water shoes. Solid reflections on the findings	All data from each classmate on both sets of shoes were recorded. Data were analyzed to find connections to size of student and size of water shoes. Reflections were limited	All data from each classmate on both sets of shoes were recorded. Data were analyzed to find connections to size of student and size of water shoes.	Data was incomplete
Ideas	Own ideas in journal were creative, using experiences and inspiration from the water shoes experiment to design another invention	Own ideas in journal were created, using experiences and inspiration from the water shoes experiment to design another invention	Ideas were not fully developed or lacked demonstration of learning	Ideas were not fully developed AND lacked demonstration of learning